U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
OFFICE OF QUALITY ASSURANCE

AUDIT REPORT M&O-ARP-98-09

OF

CIVILIAN RADIOACTIVE WASTE MANAGEMENT SYSTEM
MANAGEMENT AND OPERATING CONTRACTOR

AT

LAS VEGAS, NEVADA

ALBUQUERQUE, NEW MEXICO

BERKELEY, CALIFORNIA

AND

LIVERMORE, CALIFORNIA

MARCH 2 THROUGH 13, 1998

Prepared by:_____ **Date:**_____
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1.0 EXECUTIVE SUMMARY

As a result of the performance based Quality Assurance (QA) Audit M&O-ARP-98-09, the audit team determined that the Civilian Radioactive Waste Management System Management and Operating Contractor (CRWMS M&O) at the Yucca Mountain Site, Sandia National Laboratories (SNL), Lawrence Berkeley National Laboratory (LBNL), and Lawrence Livermore National Laboratory (LLNL) are satisfactorily implementing an effective QA program for the processes and controls related to CRWMS M&O activities supporting Work Breakdown Structure (WBS) 1.2.3.14, In Situ Thermal Test, Drift Scale Heater Test (DST).

The audit was performed based on reviews of the pertinent documentation relative to in-process deliverables, as-built instrumentation data and ambient characterization data, and Scientific Notebooks (SN); interviews with management and science personnel responsible for the process and products; follow-up to the past Exploratory Studies Facility (ESF) Thermal Test Audits (SNL-ARP-97-14 and LLNL/LBNL-ARP-97-16); follow-up to the Drift Scale Preparedness Assessment Results report conducted last fall; and direct observations of the DST. The audit team analyzed and evaluated information gained throughout this process in order to make the determination that the CRWMS M&O is satisfactorily implementing an effective QA program consistent with project goals.

The audit team identified one deficiency that resulted in the issuance of a Deficiency Report (DR) and five deficiencies that were either evaluated and corrected during the course of the audit and/or referred to existing open deficiency reports that address the same programmatic issues for resolution. These conditions are described in Section 5.5. Four process recommendations were also made and are addressed in Section 6.0 of this report.

DR LVMO-98-D-064 documents that the Quality Assurance Requirements and Description (QARD) document requirements are not being followed for the control of Measuring & Test Equipment (M&TE) installed in the DST. A deficiency corrected during the audit concerned Test Coordination Office (TCO)/LANL procurement documentation that lacked adequate traceability of the procuring document to the items calibrated and suppliers documentation. While the deficient procurement packages were corrected during the audit, the overall procurement issue is adequately addressed in the project Corrective Action Request (CAR) VAMO-98-C-005. A deficiency was also identified relative to the calibration by an unapproved supplier of laboratory equipment used by LLNL. This issue is also being referred to CAR VAMO-98-C-005 for resolution. The audit team identified a deficient condition relative to planning at SNL and LLNL. Work Agreements and Activity Plans at SNL and LLNL, respectively, were corrected during the audit; and, while no deficiency reports were generated, the issues are being referred to DR LVMO-98-D-027 for consideration under extent of condition relative

to planning issues for the Yucca Mountain Site Characterization Project (YMP). It was identified during the audit that the CRWMS M&O and the laboratories had not implemented procedures for the management and control of electronic data as required by the QARD, Supplement V. Again, this deficient condition was referred to an existing project DR LVMO-98-D-055 for resolution. Finally, required training to a Sample Management procedure was not conducted as required for some LLNL personnel. This deficiency was referred to existing DR LLNL-98-D-018 for resolution. All of these deficiencies were examined and believed to have little or no technical impact on the quality of the work being performed.

2.0 SCOPE

This performance based audit of the CRWMS M&O contractor was a limited scope audit conducted by a team of auditors from the Office of Quality Assurance (OQA) and two Technical Specialists. The audit was conducted to evaluate the adequacy and effectiveness of the CRWMS M&O controls for the processes and activities related to CRWMS M&O activities supporting WBS 1.2.3.14, In Situ Thermal Test, DST. This was accomplished through an assessment of scientific investigation and planning activities to the critical process steps developed by the audit team and the CRWMS M&O management organization. The audit was intended to determine that controls for test planning, procurement and scientific investigation activities for the DST are adequate and being effectively implemented at YMP, SNL, LBNL and LLNL in accordance with program requirements. The degree to which the CRWMS M&O manages and integrates ESF DSTs with test planning activities to meet critical process steps, management commitments and expectations and program requirements, e.g., the QARD document [Department of Energy (DOE)/RW-0333P, Revision 7] was also an element of the scope of this audit.

The processes and activities relative to the In Situ Thermal Test, DST were evaluated during the audit, in accordance with the audit plan.

PROCESS/ACTIVITY/END-PRODUCT

There were no completed end-product deliverables that were evaluated during the audit. However, in-process deliverables, the Data Control System (DCS), as-built instrumentation data and ambient characterization data, in conjunction with planning documents and interfaces associated with this activity, were evaluated as part of this audit process.

The activities evaluated included the OCRWM QARD, Supplement III, Control of Scientific Investigations (DOE/RW-0333P, Revision 7) requirements as well as procurement, planning and resource management activities.
The performance based evaluation of process effectiveness and product acceptability was based on:

1. Satisfactory implementation of the critical process steps;
2. use of trained and qualified personnel working effectively;
3. documentation that substantiates the quality of the products; and
4. acceptable results and adequate end products.

TECHNICAL AREAS

The audit included a technical evaluation of process effectiveness and controls for producing acceptable products. Details of the technical evaluation are included in Section 5.4.

3.0 AUDIT TEAM AND OBSERVERS

The following is a list of audit team members and their assigned area of responsibility and observers. An alternate Audit Team Leader (ATL) was added to assist on the audit due to the unavailability of the original ATL during portions of the audit:

Name/Title/Organization	QA Program Requirements/
Kenneth O. Gilkerson, ATL, OQA	Supplement III, Critical Process Las Vegas (LV), Albuquerque (AB)
Donald J. Harris, ATL, OQA	Supplement III, Critical Process
Michael A. Goyda, Auditor, OQA	Supplement III, Critical Process Steps, Procurement, M&TE, DCS (LV), (AB)
John R. Doyle, Auditor, OQA	Supplement III, Critical Process Steps, M&TE, Procurement (LV), (AB), (BY), (LM)
S. Thomas Freeman, Technical Specialist, Woodward Clyde Consultants	Supplement III, Planning, Critical Process Steps, Rock Mechanics (LV), (AB)
F. Harvey Dove, Technical Specialist Golder & Associates	Supplement III, Planning, Critical Process Steps, Chemical &

There were no observers during the audit; however, the Nuclear Regulatory Commission On-Site Representative, Bill Belke, was present during the Pre-Audit Meeting.

4.0 AUDIT MEETINGS AND PERSONNEL CONTACTED

A pre-audit meeting was held in Las Vegas, Nevada, with the CRWMS M&O Natural Environment Programs Office (NEPO) management, the TCO, SNL, LBNL, and LLNL personnel on March 2, 1998. The audit was conducted in Las Vegas, Nevada; the Yucca Mountain Site; Albuquerque, New Mexico; Berkeley, and Livermore, California. A daily debriefing was provided to DOE and CRWMS M&O management during the two week audit while briefings were held with laboratory management staff on location to discuss any issues and potential deficiencies identified at the various laboratories. A daily audit team meeting was also held each evening to coordinate the pace of the audit, discuss issues, and to process recommendations and potential deficiencies. The audit was concluded with post-audit meetings held in Las Vegas, Nevada, on March l3, 1998. Personnel contacted during the audit are listed in Attachment 1. The list includes those who attended the pre-audit and post-audit meetings.

5.0 SUMMARY OF AUDIT RESULTS

5.1 Program Effectiveness

The audit team determined that, in general, with the exception of areas identified in the deficiencies cited, process controls are being effectively implemented by the CRWMS M&O and affected organizations for In Situ Thermal Tests, specifically the DST. The audit assessed process activities relative to the DST such as planning, instrumentation, collection of data, documentation of activities in SNs, calibration and maintenance of equipment, modeling, and follow-up to previous audits and assessments. The training and qualification of DST personnel were examined and found satisfactory for affected organizations except that this could not be completely verified for all SNL personnel during the audit. An additional training deficiency was identified for some LLNL personnel who had not read one of the Sample Management Facility procedures. A subsequent surveillance of this training and qualification will be performed at SNL and the LLNL training deficiency was referred to an existing deficiency document, DR LLNL-98-D-018. The audit team determined that CRWMS M&O/TCO, SNL, LLNL and LBNL Principal Investigators and Technical Staff planned activities and acquired data utilizing processes that should result in sound scientific interpretations and ensure quality products for the DST.

It should be noted that all of these laboratories initially relied on project study plans as their basis for project level planning in the past. Work Agreements, Activity Plans, etc. were used to perform planning at the participant level. Study plans were subsequently decontrolled and Participant Planning Sheets (PPS) were provided as an upper level planning tool. The PPS have been found to be inadequate to meet project planning needs relative to the QARD, Supplement III, requirements. While DR LVMO-98-D-027 addresses specific planning

deficiencies at the laboratories, a process recommendation is also identified in Section 6.0 of this report relative to integration of overall planing efforts.

It is believed that the real time evaluations of these activities allows the process recommendations made by the audit team to be useful in assuring the development of acceptable and meaningful quality products for the YMP.

5.2 Stop Work or Immediate Corrective Actions Taken

There were no Stop Work Orders, immediate corrective actions or related additional items resulting from this audit.

5.3 QA Program Audit Activities

A summary table of audit results is provided in Attachment 2. The details of the audit evaluation, along with the objective evidence reviewed, are contained within the audit checklists. The checklists are kept and maintained as QA Records.

5.4 Technical Audit Activities

Two Technical Specialists were utilized during this audit in the evaluation of In Situ Thermal Tests in the ESF, one specifically for Rock Mechanics and the other specifically for evaluating the Chemical and Hydrology studies. An evaluation of the overall integration and planning efforts of the CRWMS M&O was also required of the Technical Specialists.

The In Situ Thermal Tests in the ESF are complex multi-disciplinary tests involving a number of organizations on the YMP. In order for the currently ongoing DST to be successfully completed, a high degree of interaction, cooperation and integration among the various test participants is necessary. The audit of the CRWMS M&O Natural Resources Programs Office included the TCO [which encompasses Los Alamos National Laboratory (LANL) personnel], SNL, LBNL and LLNL personnel and work locations. The technical objectives of the audit assessed how the organizations were integrated to achieve the goals of the tests; an assessment of the technical quality of the work that each organization was performing; and an assessment of how the currently ongoing and planned thermal tests will contribute to the projects thermal goals and an improved understanding of thermally driven processes. Technical checklist questions were developed in the following categories: Data collection and management; Identification of data needs/modeling approach; Design requirements testing; Testing strategy; and Single Heater Test (SHT) lessons learned. Source documents for the checklist questions included: 1)BAB000000-01717-2200-00014, Revision 0, Drift Scale Test Preparedness Assessment Results;

2) BAB000000-01717-4600-00007, Revision 1, Drift Scale Test Design and Forecast Results; 3)BADD00000-01717-5705-00001, Revision 1, Ambient Characterization of the Drift Scale Test Block; and, the CRWMS M&O for WBS 1.2.3.14, In Situ Thermal Test, DST, dated November 10, 1997.

The following portions of the technical audit activities documents the areas of the performance-based audit conducted by one of the technical specialists on the audit team (Harvey Dove) at the following locations:

- Natural Environment Programs Office (NEPO) of the CRWMS M&O Contractor for the YMP in Las Vegas, NV;
- Alcove 5 of the ESF at Yucca Mountain, NV;
- LBNL in Berkeley, CA; and
- LLNL in Livermore, CA

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NEPO, Planning & Integration, Las Vegas, NV

Management and performance objectives of the DSTwere discussed with the NEPO Manager on March 2 and 5, 1998. An organizational chart for the DST was available, and the experienced staff from the SHT were used to form the core personnel for the DST. Lines of communication were established with a Monday conference call used to keep the team leads current on project status. Integration of lessons learned from the SHT and incorporated into the DST was evident with specifics cited throughout the audited organization. Planning was discussed with respect to identification of resources, realistic evaluation criteria, use of the Project Summary Schedule (PSS), and individual study plans and other implementing documentation such as SNs. The need for work packages, including PPS and additional more detailed yet effective work descriptions that were consistent within the YMP organization, was identified. See Recommendation #1 in Section 6.0.

TCO, Testing Activities, ESF Yucca Mountain Site

A site tour of Alcove 5, where the DST is located in the ESF, was completed on March 3. The flow of DST data from the parameter sensors to the data recording equipment was explained by the CRWMS M&O/TCO Data Technician. Written guidelines in the form of operational procedures to replace the current use of SNs was mentioned; however, because of the initial experimental flavor of the DST, SNs would probably be used into the near future. As the data acquisition process becomes more predictable with less likelihood of change, the notebooks may be replaced by operating procedures. Verification of data downloads from the

recording equipment to Compact Discs was accomplished visually by comparing file names and sizes. The sampling frequency of passive data acquisition was low (sampling once per hour). Principal Investigators (PI) within the YMP were the only project personnel authorized to establish and change these data sampling rates. The experimental data acquisition system could be further automated to reduce manual verification of system and data integrity. Site operational criteria and subsequent experimental changes were documented in SNs that were maintained off site.

LBNL, Hydrological Testing Activities

The audit continued at LBNL in Berkeley, CA, on March 9. SNs maintained by Yvonne Tsang and Jens Birkholzer were reviewed. These PIs are competent, qualified researchers. They maintained organized, quality notebooks. LBNL personnel were not familiar with PPS sheets and they used SNs to document their individual plans, including assumptions. One exception was the Thermal Hydrology Strategy, initially developed by Yvonne Tsang at LBNL, and later published in April 1997 by the CRWMS M&O as B00000000-01717-5705-0065, Revision 1, Updated In Situ Thermal Testing Program Strategy. Baseline data for the ground penetrating radar (GPR) was obtained in November 1997. The GPR is useful for indicating the moisture content of the rock matrix. The equipment was not calibrated, and an open DR exists as a result (DR-98-D-033).

Model predictions using the TOUGH2 software were discussed with Jens Birkholzer on March 10. The physical concepts within the dual permeability model and the effective continuum model were compared, along with their data requirements. The current model predictions for 12 hydrologic boreholes are contained in Appendix A1 and A2 of the report titled, Pre-Test Analysis of the Thermal-Hydrological Conditions of the ESF Drift Scale Test (SP9322M4). The model predictions are for temperature, gas pressure, and saturation. Grid sizing is variable and has considered lessons learned from the scale of the SHT. However, the sizing of the finite elements is more reflective of the estimate of heat gradients in the rock and the evolution of temperature and pressure with time. Because the first data package will not be available until April 1998, a comparison of predicted and measured values has not been made to date (March 1998). An open CAR exists on their software configuration management (LVMO-98-C-006).

LLNL, Chemical Testing Activities

The audit continued at LLNL in Livermore, CA, on March 11. SNs maintained by Wunan Lin were reviewed. They were maintained, quality notebooks. A reorganization of LLNL DST personnel was in progress and an organizational

chart was provided. LLNL management were familiar with the PPS. Also, they had prepared an Activity Plan (effective 2/27/98) to document the activities related to conducting measurements of thermal-mechanical, thermal-hydrological, and thermal-chemical responses to the heated rock mass in the ESF Thermal Tests. Additional laboratory and field measurement details were documented in the SNs.

Model predictions using V-TOUGH and NUFT software were discussed with Tom Buscheck on March 12. The documentation for qualification of the V-TOUGH code and the configuration management of the NUFT code were reviewed. Extensive use of an electronic notebook for tracking model input data and assumptions was noted for Tom Buscheck. The approach was also used to document the initial conditions and assumptions needed for Total System Performance Assessment calculations by computer.

The portion of the audit involving thermal rock mechanics were performed by S. Thomas Freeman, a Technical Specialist at the following locations:

- The TCO of the CRWMS M&O contractor for the YMP in Las Vegas, NV;
- Alcove 5 of the ESF at Yucca Mountain, NV; and
- LBNL in Livermore, CA.

References utilized in evaluating the SNL thermal mechanical testing activities for the DST included the following:

Elkins, Ned Z., 1997. Letter Recommending Start Date of Drift Scale Test.

Sobolik, Steven R., 1997. Memo: Data Conversion Equations and Factors to be used for SNL-Installed Instrumentation for the Drift Scale Test

Sobolik, Steven R., 1997. Outline for Drift Scale Test Data Reports, Sandia National Laboratories, Albuquerque, NM 87185-1325

Sobolik, Steven R., 1998. Technical Review of Data Conversions for SNL-Installed Instrumentation for the Drift Scale Test

Sobolik, Steven R., 1997. Work Agreement WA-0347, Revision 00, Conducting the Drift Scale Test in the ESF

TRW Environmental Safety Systems Inc., 1997. Ambient Characterization of the Drift Scale Test Block

TRW Environmental Safety Systems Inc., 1997. Drift Scale Test Design and Forecast Results

TRW Environmental Safety Systems Inc., 1997. Drift Scale Test Preparedness Assessment Results

U.S. Geological Survey. Geologic Map and Predictive Cross-Section along the Cross-drift Alignment, Yucca Mountain, Nye County, Nevada.

SNL- Thermal Rock Mechanics Evaluation:

The Heated Drift Test apparently began in December 1997, but the first submittal of data from the test had not been officially submitted to SNL at the time of the audit. Therefore, the audit focus was on the planning for analyzing the data. The audit also focussed on how the results of the test will be used in later activities to evaluate the performance of the rock mass surrounding the repository.

The audit team interviewed the SNL PI responsible for instrumentation and testing (Mike Riggins) and reviewed his four volume Scientific Notebook, initially in Las Vegas and later at SNL. As noted in the Technical Checklist, the SN generally appeared to be thorough and well prepared. In addition, plans covering the instrument installation, pre-test characterization, and the data collection system for the Heated Drift Test were also thoroughly prepared. The plans for the data evaluation and analysis are brief.

Interviews and technical discussions regarding checklist questions were held with Mike Riggins, Ray Finely and Steve Sobolick at SNL in Albuquerque, NM. A key checklist question involved how will the information gained from the Single and Heated Drift tests be correlated to the rock mass anticipated in the majority of the repository, which is apparently stratigraphically lower than the geologic unit where the tests are located. As noted in the checklist, a key reason for the new Enhanced Characterization Repository Block (ECRB) drift will be to help resolve

this concern. In preparing for the tests to be completed in the ECRB drift the following observations are made.

Great effort has been spent on the Single Heater and Heated Drift tests and their associated numerical models. Great effort has also been spent characterizing the rock mass and its discontinuities found in investigation borings; bore holes drilled for instrument installations; and as-built geologic mapping of the ESF North Ramp, the ESF Main Drift, the Observation Drift, the Connecting Drift, and the Heated Drift. However, it has been difficult, based on the reports that have been reviewed, to see how these two important data sets have been or will come to

together to accurately model the repository response.

The audit team understand that limitations have been recognized in utilizing various empirical rock mass classification systems to correlate data from as-built geologic mapping to estimates of rock mass deformation modulus or other rock mass properties for use in numerical models. Without some method of correlating the variations in lithology and especially the variations the degree of fracturing seen in the underground openings with the model input parameters, it is difficult to see how a reasonable demonstration of anticipated repository response can be developed using numerical models.

Discussions ensued that the variations in rock mass characteristics presently exposed in the underground openings are small relative to the range in the spectrum of rock mass characteristics covered by the various rock mass classification systems. This implies that the range in rock mass conditions exposed in the repository will not significantly effect the model simulations. Yet, it is not clear how the results of the SHT or the results that might be expected from the Heated Drift Test will support this hypothesis under the scrutiny of regulatory or public review. For the most part the SHT was in a relatively massive block of rock. The layout of the instruments in the Heated Drift Test may not offer the opportunity to test the response of rock mass with varying discontinuity frequencies and persistence or variations in lithology.
It is the audit team's understanding that there was limited opportunity to utilize as-built geologic mapping of the Heated Drift in the lay-out and position of the instruments that were installed in that drift. The team was told that, fortuitously, the conditions exposed in the Heated Drift would not have significantly altered the layout of the instruments. It is not clear that the range in rock mass characteristics exposed in the Heated Drift represent the full range of rock mass characteristics in the final repository.

Process recommendations resulting from the preceding observations and evaluations are presented in Section 6.0 of this report as Recommendations #2 through #4.

5.5 Summary of Deficiencies

The audit team identified six deficiencies during the audit for which one new DR has been issued. The other five deficient conditions are addressed either as deficiencies corrected during the audit and/or referred to existing deficiency documents identified in 5.5.3.

A synopsis of the deficiencies documented are detailed below. The DR generated during this audit have been transmitted to the CRWMS M&O under separate letter.

5.5.1 DR

As a result of the audit, the following DR was issued:

LVMO-98-D-064

Instruments requiring calibration on a periodic basis and minimally before and after the tests have been installed in the Heated Drift for the DST. It is believed that these instruments cannot be retrieved without damage after the test for calibration. Additionally, if they fail during the tests or are suspected to be out of calibration they cannot be segregated or flagged or tagged out of service to preclude inadvertent use. The QARD requires these calibration provisions to be met. These instruments were put into service without getting the applicable M&TE program requirements changed and without having the appropriate planning documents address these issues prior to installation.

5.5.2 Deficiencies Corrected During the Audit

As part of the evaluation for procurement of calibrated items for use on the DST, a review was conducted of DST/TCO procurements by LANL. The Audit Team determined through a review of five (5) DST Data Collection System (DCS) calibration procurement documentation packages that the organizations performing the calibrations were not identified on the procurement documents. An additional five (5) DST DCS calibration procurement documents identified multiple pieces of M&TE to be calibrated without reference to the M&TE identification or serial numbers. As such, traceability from the procurement documents to the supplier's

Certificate of Calibration (C of C) was not maintained. These conditions were brought to the attention of the DST TCO and efforts were completed during the course of the audit to annotate the calibration supplier on all DST DCS calibration procurement documents. In addition, the serial numbers of the calibrated M&TE were also annotated on all DST DCS calibration procurement documents to restore the integrity of the traceability to the supplier's C of C. While the specific deficient procurement packages were corrected during the audit, the overall procurement issue is adequately addressed in the project CAR VAMO-98-C-005.

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Work Agreements and Activity Plans at SNL and LLNL, respectively, were corrected during the audit and, while no deficiency reports were genereated, the issues are being referred to DR LVMO-98-D-027 for consideration under extent of condition relative to planning issues for the YMP. The DST Preparedness Assessment revealed that the SNL Work Agreement for the FY97 work was prepared under a previous revision of Quality Assurance Implement Procedures 1-5 (Revision 11 instead of Revision 12). A brief explanation of the impact (considered minor by the Preparedness Assessment team) was recommended to be inserted into the SN. A memo to the SN by M. Riggins to SN#-1-WA-0333 was generated and placed in the SN during the audit.

The LLNL Activity Plan AP-ESF-001 (dtd. 2/27/98), "Planning Documentation for ESF Thermal Tests," was found deficient to the requirements of LLNL Quality Procedure 2.1 relative to including all required elements, e.g., identifying software used and a records section. LLNL made corrections to this and reissued it during the audit. Again, while specific problems were corrected during the audit, DR LVMO-98-D-027 is an open deficiency document being used to track and resolve planning issues common to the OCRWM program.

5.5.3 Follow-up of Previously Identified CARs, DRs and PRs

Numerous open deficiencies existed at the time of the audit resulting in the deferring of problems found during this audit to those deficiency documents for evaluation and resolution. Some were specific to the ongoing Thermal Tests (SHT/DST), while others were applicable as indicators of problems that are project-wide.

DR YM-97-D-025 regarding the installation of instruments and equipment that were not procured and calibrated in accordance with program

requirements was evaluated during the audit. Although a response has been accepted with proposed remedial and corrective actions pending final verification, similar procurement issues were identified at LLNL during the previous Thermal Audit (DR YM-97-D-047) as well as procurement problems at LBNL, SNL, LANL and U.S. Geological Survey (USGS). These issues were all rolled into the project CAR VAMO-98-C-005. Subsequent to this, another instance of LLNL purchasing services from an unqualified supplier as identified in DR YM-97-D-047 was identified during this audit. CAR VAMO-98-C-005 is intended to address and resolve all the programmatic procurement issues that have hampered the YMP over the last several years inclusive of all the Affected Organizations.

DR YM-97-D-032 relative to study plans not being maintained, kept current or used as required was closed last year with the decontrolling of study plans. Without this mechanism at the OCRWM project level or another upper level planning procedure in place, a dependence on the PPS in conjunction with Affected Organizations participant level planning documents was not found to be uniform or effective during the audit. See Process Recommendation #1 and DR LVMO-98-D-027 on planning. This was a concern identified to management in the audit report LLNL/LBNL-ARP-97-16 issued last year.

DR LVMO-98-D-027 on planning was issued prior to this audit based on planning deficiencies denoted at USGS and LANL, and subsequent planning deficiencies denoted for the DST by the CRWMS M&O Preparedness Assessment Team. This DR was submitted to the CRWMS M&O for resolution on a project wide basis since planning activities identified in the QARD were determined to be ineffectively implemented for the Project. This audit report further substantiates this concern and made a Process Recommendation relative to planning commitments for the DST.

Deficiencies were denoted during previous audits of the CRWMS M&O and LBNL that QARD, Supplement V, requirements for the Control of Electronic Data were not being implemented by procedures and documented in DR LVMO-98-D-055. The DST audit identified that the NEPO/TCO did not have procedures that met these requirements either, although some of the controls were identified in SNs. Again, this deficient condition was referred to the existing project DR LVMO-98-D-055 for resolution.

Follow-up to the use of GPR was evaluated at LBNL. The equipment was not previously calibrated, and an open DR exists as a result (DR-98-D033).

Although DR YM-97-D-048 identified problems with Scientific Notebooks at LBNL during the Thermal Test Audit LLNL/LBNL-ARC-97-016 and is still open, no additional concerns were denoted during this audit. In fact, the DST SNs had been corrected and were found to be in good order. LBNL SNs outside of the DST area are being evaluated by LBNL prior to this issue being closed out.

Additionally, it was denoted that at LBNL the Tough2 computer code is still being utilized and an open deficiency document (LBNL-98-D-024) addresses a problem with this code having not been appropriately verified and validated for the versions of the codes being used. Also, a CAR with project wide implications (LVMO-98-C-006) relative to computer codes not being appropriately controlled under configuration management was issued previous to this audit.

It was found during this audit that training to a Sample Management procedure was not conducted as required for some LLNL personnel. This deficiency was referred to existing DR LLNL98-D-018 for resolution which had previously been identified at LLNL for similar problems.

6.0 RECOMMENDATIONS

The following process recommendations resulted from the audit and are presented for consideration by management. Process Recommendation #1 represents a programmatic (QA) recommendation as well as a specific technical recommendation identified by both the Technical Specialists and QA Auditors as an issue. While Recommendations #2 through #4 were identified at SNL, the issues should be evaluated in light of the whole Thermal Test effort for the project.

1. It is recommended that the YMP planning documentation from the DOE to the CRWMS M&O to the implementing organizations be standardized to include a consistent work package with sufficient detail and acceptance criteria to ensure a quality product. Planning systems within the upper level and lower level organizations could be improved. While it should be noted that, from a process

basis, planning within the TCO was excellent, not everything flows consistently to each Affected Organization and the procedures in place do not fully depict the actual planning process that was observed. The PPS as a planning document in and of itself is inadequate, study plans are no longer used as a planning document and LBNL does not even see the PPS. While SNL effectively uses Work Authorizations and LLNL uses Activity Plans as planning documents, inconsistencies in meeting program requirements were noted. While it is noted that a Yucca Mountain Site Characterization Project Administrative Procedure is in the works for establishing some consistency in planning on the project, it is recommended that the YMP planning process from the DOE to the CRWMS M&O to the implementing organization be standardized into a consistent work package with sufficient detail and acceptance criteria to ensure a quality product.

2. Given the experience gained in the SHT and the Pre-Heated Drift Test Simulation, we recommend developing a more rigorous data analysis and evaluation plan and provide documentation for such a plan in the appropriate SN. A little front-end thought into the data analysis and evaluation process can go a long way in focussing the analysis on the most relevant issues. A pre-prepared data analysis and evaluation plan could also help in providing more real time responses and documentation, if the acquired data force changes in the analysis processes.

3. We recommend re-calibrating published rock mass classification systems to the Yucca Mountain conditions, develop a new classification system specifically for Yucca Mountain, or demonstrate that variations in the rock mass characteristics do not significantly affect rock mass performance due to thermal changes. This may help provide a mechanism that can accommodate the various changes in the rock mass characteristics, which can be expected throughout the repository into the numerical simulations of repository response.

4. Management and the whole In Situ Thermal TestTeam should continually balance the objectives of specific construction and testing activities against the overall project goals. Specifically, we recommend that the sequence of construction and test implementation should be adjusted when necessary so that the results from past tests or work activities can be utilized effectively in the planning and design of future tests in order to capture and resolve open technical issues. For example, the rock mass characterization data collected through as-built geologic mapping and other means, after a particular drift is constructed, should be available and used in design and planning of future tests that might be implemented in that drift. If we are to help resolve issues such as the issue discussed under item # 23 of the Checklist, this scheduling problem should be corrected. Specifically, future as-built geologic data from the upcoming ECRB drift should be used in the planning and design of future tests in that drift.

Attachment 1: Personnel Contacted During the Audit

Attachment 2: Summary Table of Audit Results

ATTACHMENT 1

Personnel Contacted During the Audit

Name	Organization/Title	Preaudit Meeting	Contacted During Audit	Postaudit Meeting
Barker, Glen	SNL, Senior Technician		X	
Birkholzer, Jens	LBNL, Numerical Modeler		X	
Belke, William	U.S NRC, On Site Representative	X		
Blaylock, James	U.S. DOE/OQA Verification Lead	X		
Bodvarsson, Bo	LBNL, Project Manager		X	
Blink, James	LLNL, Lab Lead	X		X
Brodski, Nancy	SNL, PI Thermomechanics		X	
Bryan, Barbara	LLNL, Administration		X	
Burningham, Andrew	TCO (LANL) EA	X	X	X
Busheck, Tom	LLNL, Numerical Modeler		X	
Chuu, Yoe Chen	LLNL, Biomedical Scientist		X	
Datta, Robin N.	M&O, Thermal Test Lead	X		X
Davalier, Susan	LLNL, Software Technician		X	
DeRoach, Laura	LLNL, Chemist		X	
Fenster, Richard	M&O/TCO			X
Fernandez, Michael	LLNL, Engineer		X	
Finley, Ray	SNL, PI		X	
Fissekidou, Vivi	LBNL, EA		X	
George, Tim	SNL, Thermal Testing		X	
Graff, James	OQA On Site Representative		X	
Greene, Henry	OQA/QATSS	X		
Griego, Gene	TCO Field Test Rep		X	
Hardy, Robert	SNL Geomechanical Technician		X	
Hastings, Cheryl	LBNL, Program Administrator		X	
Hayes, Larry	M&O NEPO Manager		X	X
Homuth, Fred	M&O/TCO			X
Justice, Robert	M&O, EA	X	X	
Lentz, F. Hugh	OQA/QATSS Engineering	X	X	X
Lewis, Chris	M&O, Sample Management Facility	X		
Lewis, Lin	LLNL, Software Engineer		X	
Lin, Wunan	LLNL, PI	X	X	X
Lum, Clinton	M&O/SNL		X	
Mangold, Donald	LBNL, EA Manager	X	X	X
Meike, Anne-Marie	LLNL, PI		X	
Monks, Royce	LLNL, EA Manager	X	X	
O'Shea, Colleen	LBNL, Procurement/Records		X	
Orrell, Andrew	SNL, Laboratory Lead		X	X
Pelletier, John	OQA On-Site Representative		X	
Peters, Mark	NEPO/TCO Thermal Test Lead	X	X	X
Price, R. H.	SNL, EA		X	
Podobnik, John	LLNL, Project Controls Manager		X	
Reynolds, Tom	M&O Procurement		X	

Riggins, Mike	SNL, PI	X			X	X
Ruddle, Dave	LLNL, Senior Technician				X	
Schelling, Joe	SNL, QA Lead				X	
Sobolik, Steve	SNL, PI			X		
Spangler, Elaine	M&O Technical Review Coordinator	X				
Stevens, Elise	M&O/DCS Data Clerk				X	
Tsang, Yvonne	LBNL, PI				X	
Wagner, Ralph	M&O NEPO	X				X
Wang, Joe	LBNL PI				X	
Warren, Charles	OQA/QATSS	X				X
Weaver, Doug	DST Project Engineer	X	X	X		
Wang, Joe	LBNL, PI				X	
Wilder, Dale G.	LLNL, Technical Area Lead				X	
Yasek, Robert	U.S. DOE, AML/Thermal Testing	X				X
Ziemba, James	OQA On-Site			X		

LEGEND:

EA..... Engineering Assurance
PI..... Principal Investigator
TCO..... Test Coordination Office
SNL..... Sandia National Laboratories
NEPO..... Natural Environment Programs Office
QATSS.... Quality Assurance Technical Support Services
AML..... Assistant Manager, Licensing
LANL..... Los Alamos National Laboratory
LLNL..... Lawrence Livermore National Laboratory
LBNL..... Lawrence Berkeley National Laboratory
OQA..... Office of Quality Assurance
DST..... Drift Scale Heater Test
M&O..... CRWMS Management and Operating
U.S.DOE.. Department of Energy
NRC..... Nuclear Regulatory Commission

ATTACHMENT 2

AUDIT SNL-ARP-97-16 DETAIL SUMMARY

QA ELEMENT/ ACTIVITIES	PROCESS STEPS/ MGMT OBJECTIVES	DETAILS (Checklist)	DEFICIENCIES	REC	PROCESS EFF.	PRODUCT ADEQUACY	OVERALL
Supplement III: In Situ Thermal Tests: DST	Planning adequacy-Work activities identified and defined/documented (MO/CPS)	item 5, pg. 6	LVMO-98-D-027	REC.#1	UNSAT	N/A	SAT
	Interfaces defined. Integration of management (MO)	item 1, pg.2 item 19, pg.12	NO	NO	SAT	N/A	SAT
	Training/qualification (MO)	item 2, pg.3	LLNL-98-D-018	NO	UNSAT	N/A	SAT
	Resources: personnel, equip, communications feedback (MO)	item 3, pg.4 item 19, pg.12	NO	NO	SAT	N/A	SAT
	Lessons learned/previous recommendations (MO)	item 4-5, pgs.5-6 item 22, pg.12	LVMO-98-D-027	NO	SAT	N/A	SAT
	Controls established: Scientific notebook, technical procedures (CPS)	item 6, pg.7	NO Corrective	NO	SAT	N/A	SAT
	Intended use of data (CPS)	items 23-54 pgs. 13-21	NO	See REC #2- 4	SAT	N/A	SAT

QA ELEMENT/ ACTIVITIES	PROCESS STEPS/ MGMT OBJECTIVES	DETAILS (Checklist)	DEFICIENCIES	REC	PROCESS EFF.	PRODUCT ADEQUACY	OVERALL
	Use of contract or subtier suppliers.(CPS)	item 7, pg.8 item 12, pg.10	VAMO-98-C-005	NO	UNSAT	N/A	SAT
	M&TE installation/useage Calibration (CPS)	item 8, pg.8 items 9-10, pg.9, item 11, pg.10	LVMO-98-D-064 LBNL-98-D-033	NO	UNSAT	N/A	SAT
	Data acquisition and reporting DST (CPS)	items 21, 23-25, pgs.12-13, items 32-41, pgs.15-17	LVMO-98-D-055	NO	UNSAT	N/A	SAT
	Project Status reporting and submitting interim and final deliverables (report/products) to DOE (MO/CPS)	item 1, pg.2 item 3, pg.4 item 11, pg.10	NO	REC#2-4	SAT	N/A	SAT
	Analyze/interpret/test data (CPS)	item 21, 23-25, pgs. 12-13 items 42-54, pgs. 18-21	NO	REC# 1-4	SAT	N/A	SAT
	Control of electronic media (CPS)	item 57, pg. 23	LVMO-98-D-055	NO	UNSAT	N/A	SAT
	Software Controls (CPS)	item 29, pg. 14	LBNL-98-D-024 LVMO-98-C-006	NO	UNSAT	N/A	SAT

QA ELEMENT/ ACTIVITIES	PROCESS STEPS/ MGMT OBJECTIVES	DETAILS (Checklist)	DEFICIENCIES	REC	PROCESS EFF.	PRODUCT	OVERALL

						ADEQUACY	
	Deficiency protocol/documents NCRs, DR followup etc (CPS)	item 13, pg.10	LVMO-98-D-064	NO	UNSAT	N/A	UNSAT
	Technical Reviews of reports, data, etc required as part of deliverables (technical, QA, peer review)	item11, pg.10	NO	NO	SAT	N/A	SAT
	QA/Overview	item18, pg.11	NO	NO	SAT	N/A	SAT
	Sample Control	item 15, pg.11	NO	NO	SAT	N/A	SAT
	Records	item17, pg.11	NO	NO	SAT	N/A	SAT

LEGEND:

CDA..... Corrected During Audit
CPS..... Critical Process Steps
MO..... Management Objective